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ABSTRACT

The main purpose of this study was to investigate whether children's perceptual comprehension of symmetrical numerical displays was greater than their comprehension of asymmetrical numerical displays. Effects of sex, age and socioeconomic status were looked at. Seventy-three kindergarten and first grade children participated in the study. Materials used consisted of from one to five pegs placed symmetrically or asymmetrically in a holder, and cards with punched out holes located in the same position as the pegs. Five sets of cards, three symmetrical and two asymmetrical sets, with three cards representing each number in a set, were presented to the children. Results indicated no differences in scores for symmetrical versus asymmetrical displays. Implications of findings are discussed. (BD)

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Relations among Symmetry, Asymmetry, Perceptual Comprehension of Numerals by Kindergarten and First Grade Children

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Relations among Symmetry, Asymmetry,
Perceptual Comprehension of Numerals by
Kindergarten and First Grade Children

Symmetry seems to characterize our man-made environment including objects that we construct for daily use. Perhaps it is easier to comprehend symmetrically designed objects than asymmetrically designed ones. Or, is it more convenient to manipulate symmetrical objects than their contrary? Or, is it more agreeable to our senses to have symmetrical things than asymmetrical ones? Are manipulatory convenience and sensual agreeableness due to our environmental conditioning? These questions prompted the investigator to examine, as a starting point, the perceptual comprehension of symmetry and asymmetry.

In Rosen's study (1955), a positive relation was found between training in art and preference for complexity and symmetry. Examining the relation between creativity and preference for complexity and symmetry, Barron (1963) obtained a positive finding. McWhinnie (1966, 1968, 1970) conducted a series of studies which are related to the work of Barron and Rosen. In McWhinnie's first study, he found that boys who had received perceptual training were positively related to preferences for complexity-asymmetry on the Welsh Figure Preference Test (WFPT), but he also found that scores on the WFPT were negatively related to rating in figure drawings. In his second study, there was a mix of positive and negative findings resultant from his treatment

of perceptual training. McWhinnie's third study yielded a significant, positive relation between perceptual training programme and subjects' preference for complexity-asymmetry on the WFPT.

The purpose of this study was to investigate the following hypotheses:

(1) The scores on comprehending symmetrically designed numerals perceptually are higher than those on comprehending asymmetrically designed ones.
(2) There is a difference between kindergarten and first grade children on symmetry as well as on asymmetry scores.
(3) There is a difference between boys and girls on symmetry as well as on asymmetry scores.
(4) There is a difference between middle and lower (SES) class children on symmetry as well as on asymmetry scores.

Method

Subjects

A total of 73 children, consisting of 45 kindergarteners (two classes) and 28 first graders, and by sex, 38 boys and 35 girls, took part in this study. The children were from a small University town situated in the Eastern Canada.

Materials

The materials used in this investigation for determining the relation between perceptual comprehension of numerals and

symmetry-asymmetry and other related hypotheses were constructed in such a way that they appeared to children as a kind of toy. In the writer's judgment, this kind of toy was a novelty to most, if not all, of the children involved. The materials consisting of 5 sets, three of them were symmetrically designed and two asymmetrically designed, were made of paper-board with little pegs inserted in it. Figure 1 shows a 3-dimensional symmetrical set, and figure 2, an asymmetrical one.

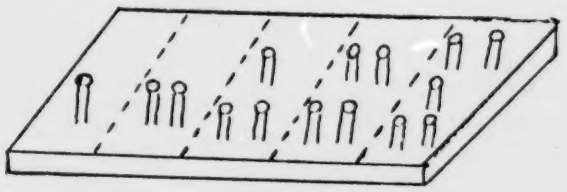

Fig. 1. Symmetrical set

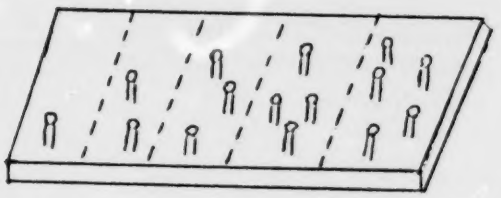

Fig. 2. Asymmetrical set.

In order to reduce the number of variables impinging on the study, the colours of all 5 sets including the pegs and the card boards were kept constant.

Since there were 5 numerals and 5 sets of materials involved in this study, five colours, namely black, red, yellow, orange and blue (in serial order) were used to construct the

card boards with holes punched in them. The holes in the card boards were designed and constructed in such a way that the holes in the card boards would fit exactly the pegs.

The colour arrangement of the card was so designed that there was a balance of colours. For example, one set began with black for numeral 1, red for numeral 2, yellow for numeral 3, orange for numeral 4, and blue for numeral 5, and another set began with red for numeral 1, yellow for numeral 2, orange for numeral 3, and so on.

There were 3 cards for each numeral in a set, and the colour of these 3 cards was also varied and balanced.

The reason why there were five numerals used in the study (represented by the number of pegs and the number of holes in the cards), namely 1, 2, 3, 4 and 5, was that the experimenter wanted to make sure that the kindergarten children had no or as little as possible difficulty in comprehending perceptually numerals up to five. What he was interested in in the study was the extent of perceptual difficulty which might be encountered by these children when the pegs were asymmetrically arranged instead of symmetrically arranged. Therefore the investigator wanted to examine whether or not, by using the materials designed in the study, these kindergarten and first grade children would have difficulty in comprehending the concept of a numeral if the objects (pegs used here) were asymmetrically arranged instead of symmetrically arranged

Definitions.

The definition of symmetry or asymmetry can become a problem of controversy, if not explicitly described. The kind of symmetry conceived of here was that when folded along a particular line, two identical halves would coincide. Figure 3 represents one of the ways to illustrate the concepts of numerals 1, 2, 3, 4 and 5 by symmetrical arrangement of pegs, and it was this way that was used to arrange pegs in this study in order to depict symmetry.

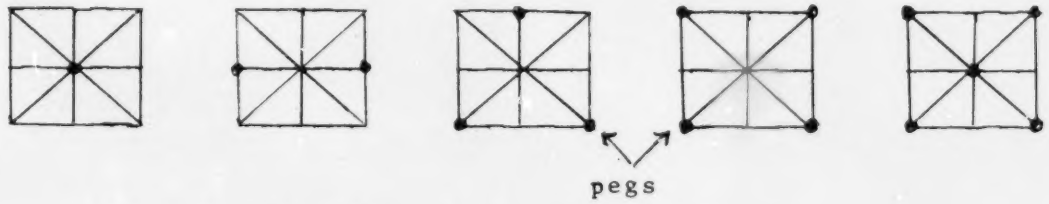

Fig. 3. Symmetrical arrangement of pegs

Figure 4 shows one of the ways to represent the numerals 1, 2, 3, 4 and 5 by asymmetrical arrangement of pegs, and it was this arrangement of pegs to depict asymmetry in this study.

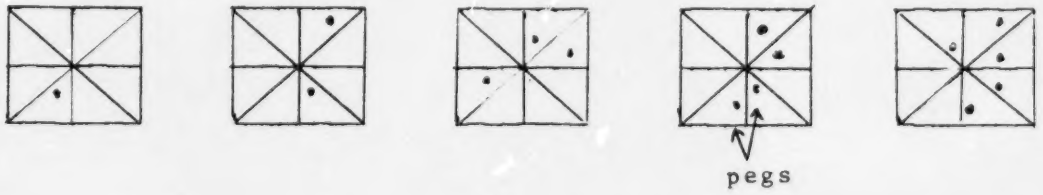

Fig. 4. Asymmetrical arrangement of pegs.

It should be made clear that the way in which symmetry and asymmetry were defined in this study could be conceived as being conventional, which obviously may not be consistent with other ways of defining symmetry and asymmetry.

Procedure

Since the materials constructed for this study called for individualized testing, the investigator collected data with the assistance of three of his graduate students. However, standard instructions and uniform criteria for accepting responses were used in all cases.

In February of 1971, the materials for measuring the perceptual comprehension of symmetry and asymmetry were individually administered to all 73 children in an appropriate place of the school or instructional premises. Children were first briefly shown the materials with cards in their respective pegs. Then the cards were unloaded and mixed. Children were then asked to place the cards into the pegs.

For the purpose of standardized scoring, it was made clear to the investigator's graduate students that only the first response in associating the number of holes on the card with the number of pegs was acceptable. What this meant was that a child's first association of a 3-hole card with 3 pegs was credited, despite the fact that he/she might have difficulty in actually inserting the card into the pegs. In other words, if a child's

first response in associating a 4-hole card with 3 pegs, his/her trial in this instance was not given credit.

It was also made clear to the experimenter's assistants that in order to qualify for the perceptual comprehension of a numeral, a child had to associate successfully, on the first response basis, all three cards (100 per cent correct) with that particular number of pegs.

Generally, children were cooperative because they liked this kind of game. For the kindergarteners, it took them about fifteen minutes, on the average, to complete the test. For the first graders, the averaged time was roughly eleven minutes.

The test administrators reported that the numerals which were often not successfully associated by the children on their first trial were 3, 4, and 5; children had no difficulty in associating the number of holes in cards with the appropriate number of pegs for numerals 1 and 2.

In the meantime, information on these children's parents' occupations was obtained from the school authorities. Warner's (1942) guidelines for categorizing these occupations were followed.

Since there were 3 symmetrical and 2 asymmetrical sets, the scores on symmetry and asymmetry were adjusted in order to be comparable. Therefore, the score range for symmetry as well as for asymmetry was from zero to thirty points respectively.

Results

Data were analyzed in accord with the hypotheses of the study, and the results are presented below.

(1) For hypothesis No. 1, a *t* test (Downie and Heath, 1970) was applied to them, first by using kindergarteners and first graders combined, and the result of $t = 0.51$, $df = 71$, was not statistically significant at .05 level. Then the kindergarten and first grade children were separated for further *t* tests, the results of $t = .77$, $df = 44$ and $t = .50$, $df = 27$ respectively were not statistically significant at .05 level. Therefore, this hypothesis was rejected.

(2) The difference between kindergarteners and first graders on symmetry scores, with a *t* value of 5.22, $df = 71$ (Guilford, 1956), was statistically significant beyond .001 level (the mean for first graders = 28.85, the mean for kindergarteners = 23.02). What this finding meant was that first graders in this study did significantly better than kindergarteners on their perceptual comprehension of symmetrically arranged numerals.

A *t* test was also applied to the difference between kindergarteners and first graders on asymmetry scores. A *t* value of 4.63, $df = 71$, obtained was statistically significant beyond .001 level (the mean for first graders = 27.75, the mean for kindergarteners = 21.53). This finding meant that the first graders did significantly better than kindergarteners on their perceptual comprehension of asymmetrically arranged numerals.

(3) The differences between boys and girls, with kindergarten and first grade combined, on symmetry scores (the mean for boys = 25.00, the mean for girls = 25.60) as well as on asymmetry scores (the mean for boys = 24.20, the mean for girls = 23.60) were not statistically significant at .05 level. Therefore, this hypothesis was rejected.

(4) The differences between children from middle class and those from lower class (with kindergarteners and first graders combined) on symmetry scores were found statistically significant at .01 level, with a *t* value of 3.92, df = 71, (the mean for middle class children = 28.20, the mean for lower class children = 23.50). What this finding meant was that middle class children did significantly better than lower class children on their perceptual comprehension of symmetrically arranged numerals.

Again with kindergarteners and first graders combined, a *t* value of 2.19, df = 71, was found for the difference between middle class children (the mean = 26.00) and lower class children (the mean = 22.70), statistically significant at .01 level. This finding meant that middle class children did significantly better than lower class children on their perceptual comprehension of asymmetrically arranged numerals.

Discussion

The investigator was cognizant of the fact that the sample of the study was relatively small, and that it would

strengthen the external validity of findings if the sample size was increased.

It would also augment the internal validity of the study if one test administrator were used in order to reduce the possible effect due to a number of test administrators involved.

Perhaps it would be appropriate to eliminate numerals 1 and 2 in both symmetrical and asymmetrical sets, because they appeared too easy for kindergarteners as well as for first graders. Instead it might be feasible to extend the numerals to 6 and 7 if the kindergarteners (5 years old) have no difficulty in comprehending them.

As revealed in the statistically significant findings, the first graders did significantly better than the kindergarteners in both the symmetrically and asymmetrically arranged numerals. Such a finding can only be regarded as validating our belief that first graders are more mature mentally, in this instance, than kindergarteners.

The second significant finding was that middle class children performed significantly better than lower class children in both the symmetrically and asymmetrically arranged numerals. For this kind of findings, perhaps one might say that middle class homes are richer, intellectually more stimulating in terms of human and material resources than lower class homes. Hence, this finding reinforces the validity of one of our commonly held beliefs.

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